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Estimating the value creation probability of mergers and acquisitions events using option pricing models

Evidence from Europe and USA

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Abstract. *This paper is proposing a new research approach to mergers and acquisitions value creation analysis. By using option pricing models we propose a new methodology on how mergers and acquisitions decisions can be analyzed using a quantitative approach, especially suitable for conglomerate type of mergers and acquisitions, where cost and revenue synergies do not represent a direct or visible financial benefit. Currently, the M&A research field is focusing mainly on the stock returns or cost synergies by the horizontal types of M&A events. The main implications of the results presented in this paper can confirm whether the top 20 M&A events that have taken place in the USA and Europe in the last 20 years were ones with high probability of value creation. In the future, this can become an important analysis point useful for the investment banking industry when evaluating M&A investments. On top, it can expand the field of research in the M&A environment.*

Keywords: mergers, acquisitions, options, probability, financial performance, Merton, KMV

Introduction

Mergers and acquisitions represent an extremely popular investment strategy for the firms that want to stimulate their growth, consolidate their competitive advantage compared to their industry peers (in the case of horizontal or vertical M&A), and generate positive returns to the acquiring company. A different type of acquisitions are the ones done by conglomerates, where many businesses from different sectors of activity are acquired by one company, that gets to be called a conglomerate (e.g. Berkshire Hathaway). According to the report done by J.P. Morgan in 2020 regarding global M&A outlook, the global volume of M&A transactions between 2015 and 2019 has an annual value range between 3.6 to 4.6 trillion dollars. On a macroeconomic perspective, the respective amounts represent a fifth or a quarter of the total GDP of the United States or European Union, respectively, as a result the mergers and acquisitions market presents systemic importance

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that can become a growth enabler for the global economy when done right or a drawback if not researched extensively enough.

While the literature regarding mergers and acquisitions is a comprehensive studied area in economics and finance research, there is no real consensus regarding the returns firms obtain as a result of the M&A activity. The literature suggests that mergers and acquisitions create synergies by reducing costs and creating economies of scale, by adopting more efficient technologies or combining R&D investments. Studies from the literature expose the fact that mergers and acquisitions do not generate positive returns for the acquiring companies. (Agrawal & Jaffe, 2000; King et al., 2004; Tuch & O'Sullivan, 2007)

The approach employed in the current paper is a quantitative one that will help to analyze the M&A decision by using option pricing models. This will serve as a proxy for the probability of positive value creation of the acquisition for a conglomerate type of business, on top, the model will offer a total valuation metric of the acquired company which can be compared with the actual deal value. The main question that the current paper is trying to answer is: can we put a clear probability of value creation in terms of profit in the event of acquiring a company by using a quantitative approach? This probability will be estimated by using both balance sheet and market data with the help of option pricing models.

The basis for the quantitative approach proposed in the current paper will be mainly done with the help of the pricing of corporate debt paper developed by Merton (1974), the pricing of options developed by Black and Scholes (1972) and the KMV model developed by the KMV Corporation (2003) in order to model the default risk. All these methodologies have as objective to model either option pricing or default risk of companies, but at the same time they can provide probabilistic solutions with regard to probability of execution of a certain plain-vanilla option (be it either a call or a put) or the probability of default of a specific company based on balance sheet and market data. We will revisit these approaches and propose a theoretical method to estimate the probability of value creation as a result of an M&A event.

Literature review

There are three types of mergers and acquisitions: horizontal, vertical and conglomerate. The horizontal integration or horizontal merger implies the fact that the companies involved in the transaction produce or deliver the same goods or services; the vast majority of M&A deals are of this type. Examples of horizontal mergers can be represented by Microsoft and Linkedin, in the technology industry, or by Anheuser-Busch InBev and SABMiller, in the beer producing industry. Horizontal mergers often attract the attention of competition authorities, because any reduction in the number of firms that operate in the same industry can provide increased market power to the companies that survive and especially to the acquirer (Lipczynski et al., 2017).

The usual reason for M&A deals is to obtain cost synergies and efficiency effects that in the end will create value for shareholders (Tuch & O'Sullivan, 2007; Vaara, 2002). Previous studies in the area of mergers and acquisition indicate, in general, positive returns on the short term for the acquired companies (Martynova & Renneboog, 2008). Despite this fact, empirical studies bring to light findings that, most of the time, effects post-acquisition did not successfully increase the financial performance of the acquiring companies. On top, there are numerous studies in the literature that prove that the returns of the acquiring companies become negative in post-acquisition year or in the best case scenario it does not differ significantly from 0 from a statistical point of view (Agrawal & Jaffe, 2000). In empirical studies regarding post-acquisition financial performance (King et al., 2004; Tuch & O'Sullivan, 2007; Dutta & Jog, 2009), it is pointed out

that, on average, the M&A activity does not lead to superior financial performance for the acquiring companies. These studies expose big variations in mergers and acquisition performance, about 40% of the acquiring companies obtained positive returns after 2 or 3 years post-acquisition, and 50% of the companies suffered losses from the respective transactions.

King et al. (2004) concluded at the time that a big part of the variations in the post-acquisition performance are moderated by unspecified variables mentioned in research up until that point. On top, it suggests that future research should investigate factors that lead to value creation or value reduction in M&A. Therefore, it leads to the motivation of the current paper to identify new factors and new methods and quantify M&A value creation.

The research field of M&A presents various findings regarding why and how this type of activity can create positive value for shareholders which will be presented in the remainder of this section. The current literature does not currently employ option pricing models in M&A analysis.

Current approaches in measuring mergers and acquisitions value creation

When running the mergers and acquisition financial performance analysis, research tends to split the approach either by long- or short-term analysis points of view. On the long term, according to Rani et al. (2016), regarding the real financial performance of the company compared to the rest of the industry, it is done by using classic financial metrics such as profitability ratios (ROE = Return on Equity, ROCE = Return on Capital Employed, OPM = Operating Profit Margin, NPM = Net Profit Margin, OCFR = Operating Cash Flow Ratios), expense ratios (COGR = Cost of Goods Sold Ratio, LRE = Labor Related Expense, SRE = Selling, General and Administrative Expense Ratio, RDE = Research and Development Expense Ratio), efficiency, liquidity and debt ratios (TATR = Total Assets Turnover Ratio, FATR = Fixed Assets Turnover Ratio, CATR = Current Assets Turnover Ratio, CR = Current Ratio, LR = Leverage Ratio).

In the short term, according to Rani et al. (2016), statistical methods can be used to measure the market value compared to the rest of the companies in the industry. These can be represented by models that measure abnormal returns compared to the market such as: AR (Abnormal Returns Model), CAR (Cumulative Abnormal Returns Model), or PWCAR (Precision Weighted Abnormal Returns Model).

What generates success or failure in mergers and acquisitions transactions

Renneboog & Vansteenkiste (2019) are summarizing the conclusions of 19 articles from the literature: 17 of these execute M&A analysis on short-term returns of the stock price and 9 analyze the long-term returns; 14 of the 17 short-term analyses conclude that the M&A transactions generated negative returns of the short-term stock price by using the CAR model, 7 out of 9 long-term analysis expose negative stocks returns and long term operational performance as well, 11 studies confirm that there is a negative correlation between the appetite of the CEO for acquisitions and the long-term financial performance of the company.

The aggressive bidder effect

Fuller et al. (2002) expose the fact that bidders that are more reserved in paying more for a business obtain, on average, returns of 2.74%, while the more aggressive bidders obtain only 0.52%. A similar conclusion can be found also in Antoniou et al. (2007), which concludes that bidders that are more reserved obtain returns of 1.66%; the returns are decreasing gradually becoming insignificantly different from 0 for the most aggressive bidders. Ismail (2008) is exposing as well a similar relationship with 2.67% returns for the first bid and 0.02% for aggressive bidders.

Laamanen and Keil (2008) find out that acquisition returns decline with 4.8% on a time horizon of 3 years in the case of companies that are aggressive in buying stage, Klasa and Stegemoller (2007) conclude the fact that the horizontal acquisitions bring an improvement of 1.8% of the profit margin for the companies that make only one acquisition during their lifetime, cost synergies decline gradually with 0.1% for any further acquisitions, which is a sign that the capacity for synergies is limited. The general conclusion on this front is that aggressive acquisitions do not lead to superior financial performances for the acquiring companies, and returns decrease with each acquisition made on top. One rational explanation would be that it becomes harder for the acquiring companies to benefit from synergies while being close to maximum efficiency.

CEO narcissism and experience in mergers and acquisitions

One characteristic of excessive self confidence is narcissism, defined in Aktas et al. (2016) as egocentricity, lack of empathy and a constant wish to be in the center of attention, manifested sometimes even as a contemptuous attitude towards others. Aktas et al. (2016) is using as proxy for narcissism the ratio between the statements at first person, singular ("I did") to statements at first person, plural ("We did") during the earnings calls with the wall street analysts. The authors discover using this measure that the narcissism of a CEO is negatively correlated with the returns generated by the acquisition of a company, positively with the probability of the deal closing and negative with the duration of finalizing the transaction. A very comprehensive study done by Taffler & Liu (2009) is exposing the fact that in a very representative sample of 1900 M&A deals and 3100 CEOs, CEO narcissism negatively affects acquiring firm short-term performance and a solution to this can be represented by effective corporate governance mechanisms.

The experience in M&A is relevant for the performance of the transaction. According to Jaffe et al. (2013), Aktas et al. (2011), Conn et al. (2005), there is evidence that acquisitions done by a CEO with a vast experience in these types of transactions bring superior returns in terms of cumulative abnormal returns (CAR).

The cultural effect

When a merger happens there is a very high probability that differences between organizational cultures might play a negative role in reaching cost or revenue synergies. A few classical studies in the area of cultural organization like Ollie (1994), Chatterjee (1992) and Napier (1989) expose the fact that the performance of a merger can be affected in a negative manner by factors like: employee productivity reduction, aversion for change, authority loss in management position, excessive personnel turnover, security of the workplace, and career perspectives. More recently, Deng et al. (2013) revealed that mergers and acquisitions in the United States of companies with higher investments in corporate social responsibility (CSR) generate superior profitability. On top, Caiazza et al. (2021), based on a sample of 6500 M&A bring evidence that sustainability performance matters in the long term post merger performance, and as a result the author's conclude that the shareholders value is bringed both by sustainability and financial factors.

The political risk on top of all of the above is a very important factor to take into consideration, as it is proven that international acquisitions generate complexity from a political and legislative point of view. When legal systems are corrupt, buyers that are politically connected with the leaders from the respective countries obtain 20% higher returns compared to the ones not connected with the political environment (Brockman et al., 2013).

Methodology

The research methodology adopted in this paper is following a quantitative approach, using option pricing models, more specifically Merton & KMV models to adapt and estimate the probability of positive value creation as a result of the largest 20 M&A events in history, these contain the top 10 of the largest mergers and acquisitions ever done in USA and top 10 in Europe. The value creation probability computation is applied to the target companies in each of the 20 events. Up until now in terms of quantitative research the latest literature studying M&A financial performance is using in terms of methodology statistical methods such as multivariate OLS regressions (Cui & Chi-Moon Leung, 2020) to determine if managerial abilities of the company leadership of acquiring companies can represent a significant factor in the long term performance, or paired samples t-test (Rani et al., 2016) in order to check the statistical significance of the financial performance generated by the M&A events.

Table 1. Summary of the companies analyzed

Acquirer		Target				
Symbol	**Region**	**Symbol**	**Region**	**Year**	**DV - Bln $**	**Deal Purpose**
AOI	USA	TWI	USA	2001	181.57	Expand in foreign markets
ALT	WE	ALT	WE	2015	145.71	Other
VRZ	USA	VRZ	USA	2014	130.30	Create synergies
SHR	WE	PMI	WE	2008	113.27	Increase shareholder value
ANH	WE	SAB	WE	2016	110.65	Expand in foreign markets
UNI	WE	UNI	WE	2020	106.88	Strengthen existing operations
T	USA	TWI	USA	2018	101.50	Create synergies
RFS	WE	ABN	WE	2007	98.19	Create synergies
RDP	WE	SHL	WE	2005	95.44	Strengthen existing operations
BMS	USA	CGC	USA	2019	93.44	Expand in foreign markets
UTC	USA	RAY	USA	2020	89.79	Create synergies
T	USA	BSC	USA	2006	89.43	Create synergies
ABV	USA	ALR	USA	2020	83.86	Create synergies
DIS	USA	21C	USA	2019	83.02	Create synergies
RDS	WE	BGG	WE	2016	81.01	Create synergies
GXW	WE	SKB	WE	2000	78.78	Other
CCI	USA	TWC	USA	2016	78.38	Create synergies
TKP	WE	SHR	JAP	2019	76.89	Strengthen existing operations
GDF	WE	SUEZ	WE	2008	75.24	Strengthen existing operations
CMC	USA	TC	USA	2002	72.04	Create synergies

Source: Refinitiv. Regions description: USA – United States of Americа, WE – Western Europe, JAP – Japan.

Years of acquisition are ranging between 2001 to 2020 and total deal value for the events is 2 trillion dollars, please refer to Table 1 for the deal value of each event in billions of USD. What is important to point out is that half of the transactions (10 out of 20) were made according to the deal synopsis provided by Refinitiv to create synergies, 4 to strengthen existing operations, and 3 to expand presence in new foreign markets. The full summary of the events can be found in Table 1, and Table 2 represents a legend for the company names of each company symbol.

Table 2. Company Legend

Acquirer	Target
AOI = America Online Inc	TWI = Time Warner Inc
ALT = Altice SA	ALT = Altice SA
VRZ = Verizon Communications Inc	VRZ = Verizon Wireless Inc
SHR = Shareholders	PMI = Philip Morris Int
ANH = Anheuser-Busch Inbev SA/NV	SAB = SABMiller PLC
UNI = Unilever PLC	UNI = Unilever NV
T = AT&T Inc	TWI = Time Warner Inc
RFS = RFS Holdings BV	ABN = ABN-AMRO Holding NV
RDP = Royal Dutch Petroleum Co	SHL = Shell Transp. & Trad. PLC
BMS = Bristol-Myers Squibb Co	CGC = Celgene Corp
UTC = United Technologies Corp	RAY = Raytheon Co
T = AT&T Inc	BSC = BellSouth Corp
ABV = AbbVie Inc	ALR = Allergan PLC
DIS = Walt Disney Co	21C = 21st Century Fox Inc
RDS = Royal Dutch Shell PLC	BGG = BG Group PLC
GXW = Glaxo Wellcome PLC	SKB = SmithKline Beecham PLC
CCI = Charter Communications Inc	TWC = Time Warner Cable Inc
TKP = Takeda Pharmaceutical Co Ltd	SHR = Shire PLC
GDF = Gaz de France SA	SUEZ = Suez SA
CMC = Comcast Corp	TC = AT&T Corp

Source: Refinitiv.

One of the very popular practical implementations of the Merton (1974) model is the KMV model, successfully developed and marketed by the KMV Corporation, until it was acquired by Moody's in April 2002. Up to now, the KMV model has been used in the literature to investigate the default probabilities risk of the banking system or other financial institutions (Fiordelisi et al., 2011, Fiordelisi and Marqués-Ibañez, 2013, Wang et al. 2020; Donker et al. 2020). On top, there is proof from comparative studies that the probabilities of default estimated with the KMV model is providing an improved accuracy than agency credit ratings for global financial firms (Camara et al., 2012). In order to improve our option pricing model estimation, we will closely follow the computational steps in the KMV model.

Starting from origins, the Merton (1974) model is using the market capitalization of the firm, the face value of the debt and the volatility of the stock returns for the respective firm to quantify the default probabilities. The model assumes that the company has issued a zero-coupon bond and it is supposed to default when the debt reaches maturity (at time T) and the market value of the assets (V) is going below the debt that needs to be repaid (F) . In the other scenario, the company is able to pay the debt in full and the difference is represented by the firm's capital (E_T) which can be expressed similar to the payoff of a European CALL option:

$$E_T = max(V_T - F) \quad (1)$$

Implicitly, the payoff of the call option based on the company's assets can represent a valuation metric with regards to the real present value of the company.

The KMV model assumes that the firm's assets are following a geometric Brownian motion, such that:

$$dV_t = \mu_V V_t d_t + \sigma_V V_t dB_t \quad (2)$$

Where μ_V represents the projected continuously compounded return on the firm market value of assets (V_t), σ_V represents the volatility of the company returns and dB_t represents a standard Wiener process.

The Black and Scholes (1972) formula is used to calculate the value of the firm's capital by computing the price of a Call option on the firm's assets (V_t) and utilizing as strike "price" the face value of the debt (***F***) at the maturity **T**.

$$E_t = N(d_1)V_t - Fe^{-r(T-t)}N(d_2) \quad (3)$$

In Eq. (3), E_t is the market value of the firm's equity, r is the instantaneous risk-free rate, F is the face value of the firm's debt, and N () is the cumulative normal distribution function with d_1 and d_2 calculated as:

$$d_1 = \frac{ln\frac{V_t}{F} + (r + 0.5\sigma_V^2)(T-t)}{\sigma_V\sqrt{T-t}}, \qquad d_2 = d_1 - \sigma_V\sqrt{T-t} \quad (4)$$

Using Ito's lemma, the market equity volatility of the acquired company can be expressed as a function of the unobservable term which is the volatility of the firm's assets:

$$\sigma_E = \frac{V_t}{E_t}N(d_1)\sigma_V \quad (5)$$

The default probability is then defined by the execution probability of a European Put option having as support the market value of the firm's assets and as to strike the face value of the firm's debt.

The formula for the option price can be written as follows:

$$P_t = Fe^{-r(T-t)}N(-d_2) - V_tN(-d_1) \quad (6)$$

Therefore, the default probability of the firm is denoted by the following:

$$PD = N(-d_2) \quad (7)$$

Where PD is the default probability and $N(-d_2)$ is the cumulative normal distribution function of $(-d_2)$.

The practical implementation of the KMV model is implementing a few improvements. First, the strike is replaced by DP (default point), which is calculated as per Eq. (8):

$$DP = STD + 0.5LTD \quad (8)$$

In Eq. (8), LTD is the long-term debt and STD represents short-term debt. These 2 measures are extracted from the annual balance sheet.

The risk free rate (r) is replaced by the drift term (μ_V)**.** The drift term is calculated by using the CAPM model in order to obtain the expected returns for each acquired company. Finally, the distance to default (DD) is summarized in Eq. (8):

$$DD = \frac{ln\ ln\left(\frac{V_t}{DP}\right) + (\mu_V - 0.5\sigma_V^2)(T-t)}{\sigma_V\sqrt{T-t}} \quad (9)$$

As a result, the default probability (PD) will be now denoted by the expected default frequency (EDF), and is calculated as follows:

$$EDF = N(-DD) \quad (10)$$

The proposed method in this paper is to switch the focus to Eq. (3), which represents the market value of equity for the companies acquired in the current article. Therefore, as per Merton (1974), the probability of value creation as a result of each merger will be defined as:

$$PA = N(d_2) \quad (11)$$

In order to substitute the equation in line with Moody's KMV (2003), we will use DP instead of *F,* and d_2 will be replaced by the distance to acquisition (DA)

$$DA = \frac{ln\ ln\left(\frac{V_t}{DP}\right) + (\mu_V - 0.5\sigma_V^2)(T-t)}{\sigma_V\sqrt{T-t}} \quad (12)$$

As a result, the acquisition probability (PA) will now be denoted by the expected acquisition frequency (EAF), and is calculated as follows:

$$EAF = N(DA) \quad (13)$$

Data modeling and sources

For data processing and computing purposes, we are using Matlab. The code used to estimate the results of this paper is represented by the personal processing and adaptation of the corresponding author. We use annual aggregated data from Refinitiv to estimate all the variables from the model. Description of each variable can be found in Table 3.

Table 3. Model variables

Variables	Description and source
Market Value of Equity (E)	Denoted by the multiplication of the daily observations for market price and shares outstanding of each company. Data Source: Refinitiv
Volatility of the firm's assets (σ_V)	Closely adopting the methodology of Vassalou and Xing (2004) we employ an iterative procedure using past 12 months daily data to obtain the volatility of equity (σ_E) . The equity volatility is then used as an initial value for the estimation of σ_V by solving the system of equations (3) and (5). Data Source: Refinitiv
Market value of Assets (V)	Using the Black-Scholes (1972) formula for each trading day of the past 12 months, we calculate V using E as the market capitalization by solving the equation system using formulas (3) and (5).
Face Value of Debt (L)	Face Value of Debt extracted from the Quarterly Balance Sheet. Data Source: Refinitiv
Default Point (DP)	Calculated as DP = STD + LTD. Using the Face Value of the Long-Term and Short-Term Debt from the Quarterly Balance Sheet. Data Source: Refinitiv
Risk Free Rate (r)	Monthly data for the 1-year yield of United States Treasury Bill. Data Source: Refinitiv

Variables	Description and source
Expected return of the firm's assets (μ_V)	Calculated using daily frequency observations for the CAPM Model: $\mu_V = E[Ri] = r + \beta(E[R_m] - r)$. The return of the Standard & Poors 500 Index has been used as market benchmark to compute the expected market return ($E[R_m]$) and the risk indicator (β). Data Source: Refinitiv

Source: Author's Processing.

Results and discussions

We will focus first on a qualitative note on the earnings, sales and asset multiples in order to research if the selected M&A events are either undervalued or overvalued compared to the rest of the market.

Table 4. Multiples based on deal value

Symbol	Region	P/E Ratio*	P/S Ratio*	Net Asset ratio*	Deal Purpose
TWI	USA	92.64	6.64	14.08	Expand presence in new/foreign markets
ALT	WE	2,381.80	22.85	66.96	Other
VRZ	USA	-	-	-	Create synergies
PMI	WE	16.43	1.80	6.43	Increase shareholder value
SAB	WE	46.86	8.49	5.02	Expand presence in new/foreign markets
UNI	WE	16.71	1.81	6.77	Create synergies
TWI	USA	22.66	3.56	4.18	Strengthen existing operations
ABN	WE	20.31	1.36	2.62	Create synergies
SHL	WE	4.23	0.27	0.75	Strengthen existing operations
CGC	USA	23.34	6.11	15.17	Expand presence in new/foreign markets
RAY	USA	29.51	3.26	7.40	Create synergies
BSC	USA	30.70	4.35	3.80	Create synergies
ALR	USA	(11.60)	5.34	1.36	Create synergies
21C	USA	30.52	2.84	3.96	Create synergies
BGG	WE	(47.65)	4.84	2.81	Strengthen existing operations
SKB	WE	43.74	5.75	21.80	Other
TWC	USA	39.43	3.41	9.62	Create synergies
SHR	JAP	45.56	5.54	2.41	Strengthen existing operations
SUEZ	WE	21.96	1.33	2.89	Create synergies
TC	USA	(13.34)	8.58	-	Create synergies

Source: Author's processing. Region's description: USA – United States of Amerca, WE – Western Europe, JAP – Japan. The evaluation is done for acquired companies only, for symbol description and acquiring companies please refer to Table 2. *all multiples are calculated at the moment of the merger.

From Table 4 it can be seen that the P/E Ratios of the main M&A events from the past 2 decades in majority above stock market average representative indexes as the average S&P 500 P/E ratio which can be found in Fig.1 stands historically to an average of 20.78 (excluding dotcom and the great recession asset bubbles) in the last 2 decades according to Refinitiv data, we exclude obvious outliers such as companies that generate losses or very high P/E ratios (Altice SA only) we get to an average valuation of 32.3.This means that the most sizable mergers and acquisitions

are supposed to payback the deal value in a time horizon of about 32 years assuming earnings per share growth in line with inflation, this assumption obviously excludes potential synergies generated by the acquired business. When looking at the Net asset value ratio and P/E ratio at the same time we find out clearly that we have cases where acquisitions such as Altice SA where made clearly in an overvalued manner, this can be a case of CEO overconfidence as described above. Also there are clear value propositions such as Royal Dutch Petroleum Co acquiring Shell Transportation & Trading PLC for less than their Net asset value ratio and at a very undervalued P/E Ratio of 4.23.

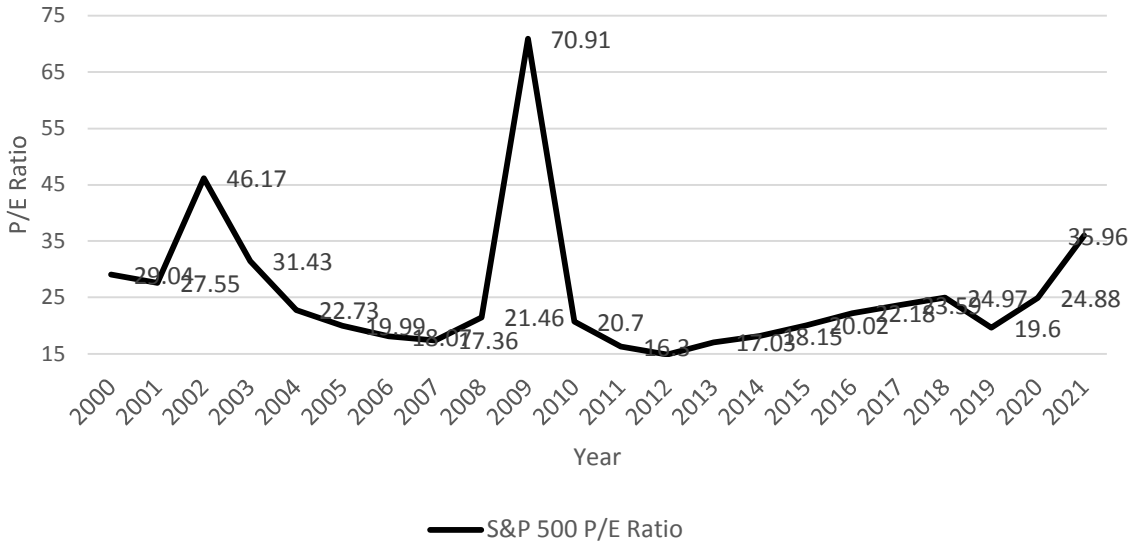


Figure 1. S&P 500 Historical P/E Ratio (2000-2021)

Source: Refinitiv. Graph Source: Author's Processing.

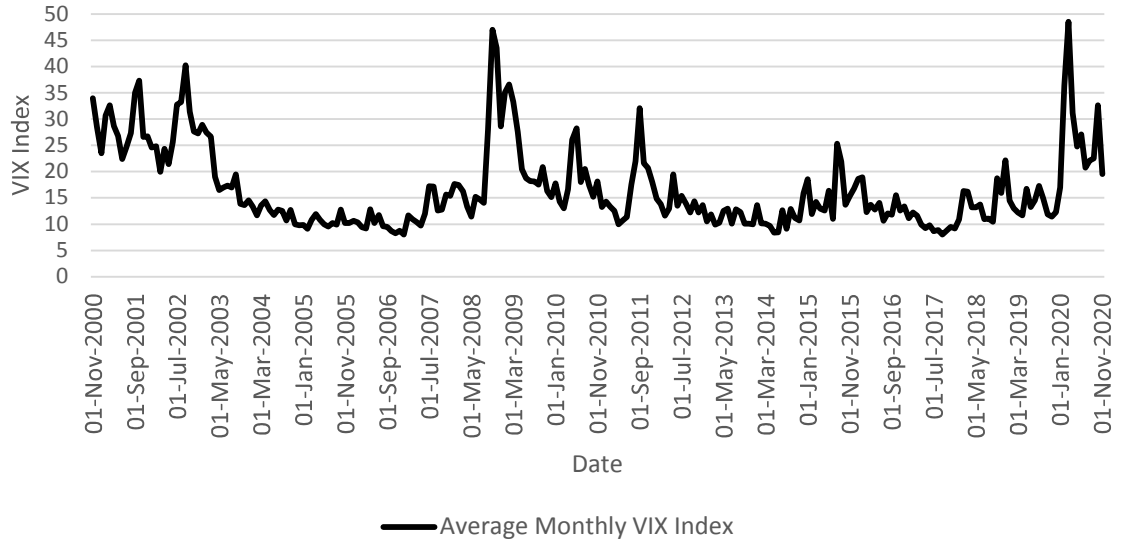


Figure 2. Average monthly VIX index (2000-2021)

Source: Refinitiv. Graph Source: Author's Processing.

Table 5. Model results: EAF, EDF, Company Valuation

Symbol	Region	EAF (%)	EDF (%)	EV (bln. $)	Risky Debt (bln. $)
TWI	USA	89%	11%	187	47
ALT	WE	70%	30%	7	27
VRZ	USA	87%	13%	13	38
PMI	WE	87%	13%	6	17
SAB	WE	92%	8%	21	17
UNI	WE	49%	51%	28	37
TWI	USA	91%	9%	31	27
ABN	WE	58%	42%	135	259
SHL	WE	95%	5%	30	27
CGC	USA	85%	15%	11	20
RAY	USA	63%	37%	73	60
BSC	USA	96%	4%	24	24
ALR	USA	76%	24%	7	3
21C	USA	90%	10%	23	24
BGG	WE	91%	9%	29	26
SKB	WE	90%	10%	43	8
TWC	USA	81%	19%	13	33
SHR	JAP	99%	1%	93	18
SUEZ	WE	45%	55%	10	10
TC	USA	59%	41%	97	89

Source: Author's processing. Region's description: USA – United States of America, WE – Western Europe, JAP – Japan. The evaluation is done for acquired companies only, for symbol description and acquiring companies please refer to Table 2. *all multiples are calculated at the moment of the merger.

Table 5 provides the EAF (expected acquisition frequency), EDF (expected default frequency), EV (Estimated Value of the Business) and Risky Debt Value. The first 2 metrics are expressed in percent and the last 2 in billions of US dollars.

According to the estimated results, several findings come to light. In Table 5 we can see that only 12 of the 20 most valuable mergers ever made have a probability for positive value creation expectancy of 85 to 99%. It is important to mention that Time Warner Inc. has been acquired twice during 20 years, first by America Online Inc. and secondly by AT&T Inc. First time it was bought for 181.6 Billion while our model estimated a valuation of 187 Billion, and second time, on a very controversial note of the market, AT&T Inc. has paid 101.5 Billion, while our model estimated at a time a valuation of only 31 Billion. When looking at ABN-AMRO NV risky debt compared to the enterprise value, it also has a probability of default of 58%, this just proves how leveraged banks were before the great recession.

The other 8 merger events range from 45 to 81%, exposing also a very high default risk from 19 to 55%. The above results do show evidence of particular cases where companies like Unilever NV and Suez SA merged with Unilever PLC and Gaz de France SA where the expected default is higher than 50%, this indicates that these companies had a very high probability of not surviving on their own, as a result this became an opportunity for Gaz de France SA and Unilever PLC to create cost synergies while engaging into horizontal M&A, intention also confirmed in deal synopsis (Table 1). This kind of acquisition would not be helpful from a financial return point of view for a conglomerate type of acquirer, as acquiring the business alone with no possible cost

synergies would be very risky according to the default probability. It is also very interesting to point out that these 2 apparently risky mergers took place in panic moments, Unilever PLC acquired Unilever NV during the great recession and Gaz de France SA acquired Suez SA during the short stock market panic of 2020 generated by the Covid-19 pandemic. Therefore, panic moments seem to be viewed by the big acquirer companies as great opportunities for horizontal acquisitions, this assumption is confirmed by Fig.2 where we can see the VIX index (the implied stock market volatility) picks up in 2008 and 2020.

Conclusion

The main contributions of the paper can have relevance for the M&A research field and practical application into the investment banking field in order to explore more quantitative analysis solutions with regards to M&A decisions or valuation. As stated in the beginning, the mergers and acquisitions market is a big part of our world economy so the importance of expanding the M&A research is a major one, and as a result it is valuable to maximize M&A financial efficiency both for shareholder value but also to grow the overall economy. Given that in terms of valuation both from a P/E ratio point of view and according to our estimated model, M&A deals tend to be more expensive compared to classic market price valuations of the companies. This can be of course linked to the fact that many articles in the literature prove that M&A deals generate very low returns, CEO narcissism can be linked with overpayment in some deals due to excessive self confidence, and generating in the end a high P/E Ratio. The CEO overconfidence can also be visible also in our table results, there we see 2 acquisitions out of 20 of all time that got closed with companies with high probabilities of default (higher than 50%).

These results need to be interpreted with caution, because one major limitation of the current study is that the adapted models in this paper represent mostly the base of the option pricing models, so they remain for now only at a theoretical stage with further development needed for practical application, at the same time this can represent an opportunity for further research in the field. As we can see from the results area, the model does not properly estimate the market value of the business in line with the deal value, as the estimated deal value is close only in a few cases versus the actual one. Therefore, the model can serve as a validation model, a further improvement for the company market value estimation can be by combining this methodology with the future estimated cash flows.

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